

Vertebrate Colour Vision

ANIM3320 - Comparative Neurobiology



🦘 colours: promote contrast perception \therefore enhance visibility of objects against surroundings



- 🦘 Colour vision:
- definition
 - requirements
 - visual pigments - evolution
 - the marsupial story

What is colour vision?

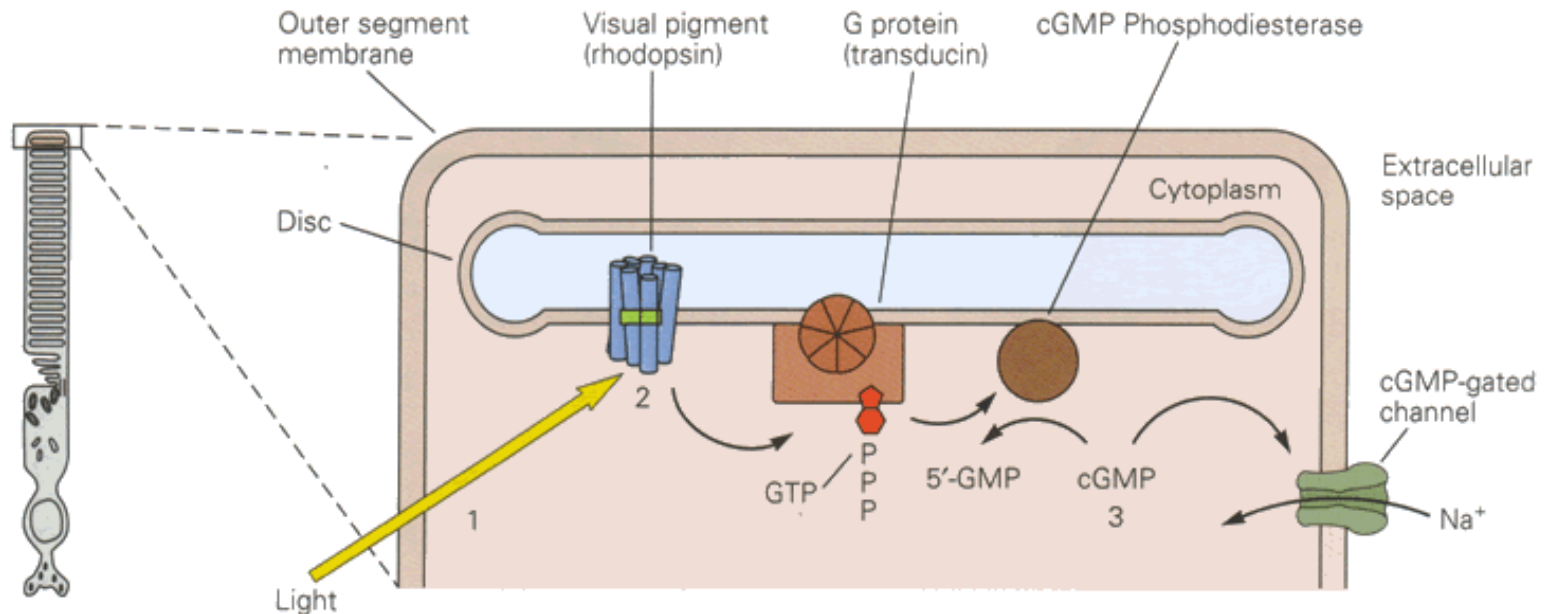
- visible light: electromagnetic waves that we can see



- ability to discriminate between different wavelengths of light
- mediated by cone photoreceptors in retina

Phototransduction

where does colour discrimination start?



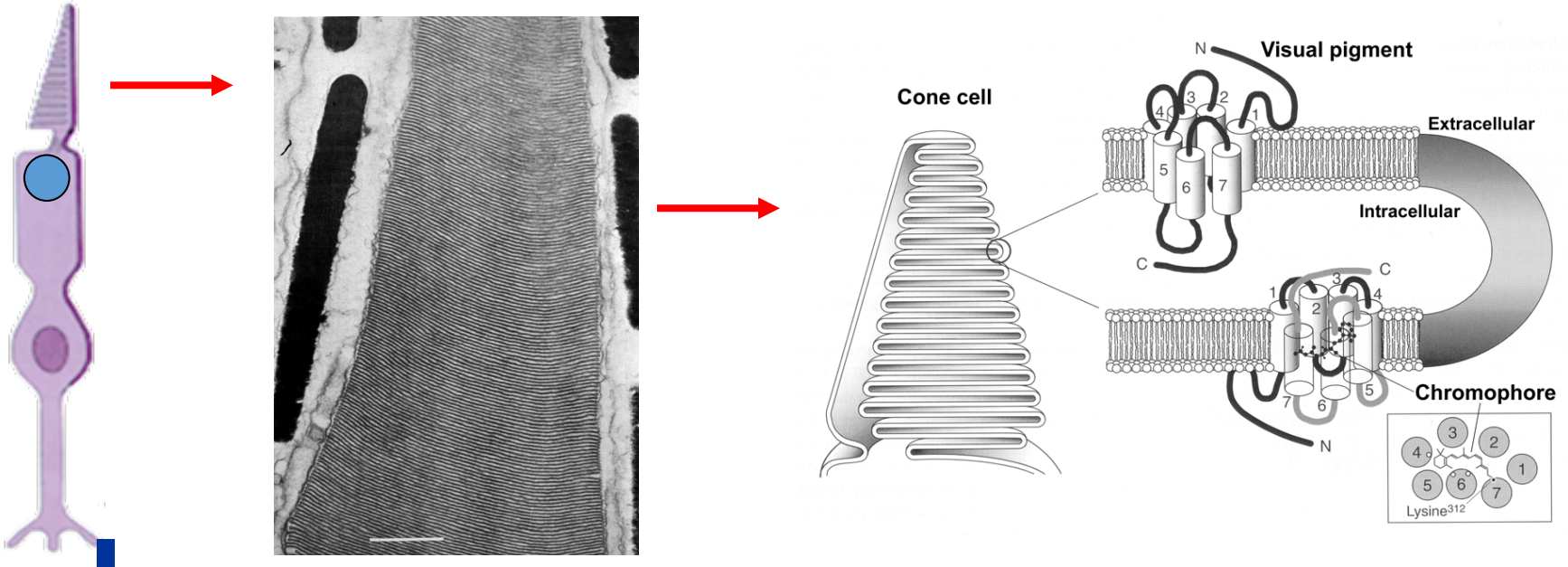
Light hits retinal

Retinal changes shape

Opsin changes shape

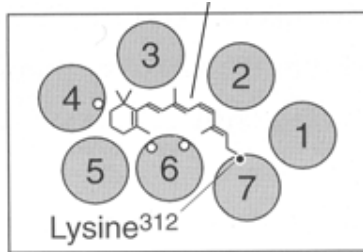
Causes intracellular changes (domino effect) and change in membrane potential (= electricity)

Focus on opsins

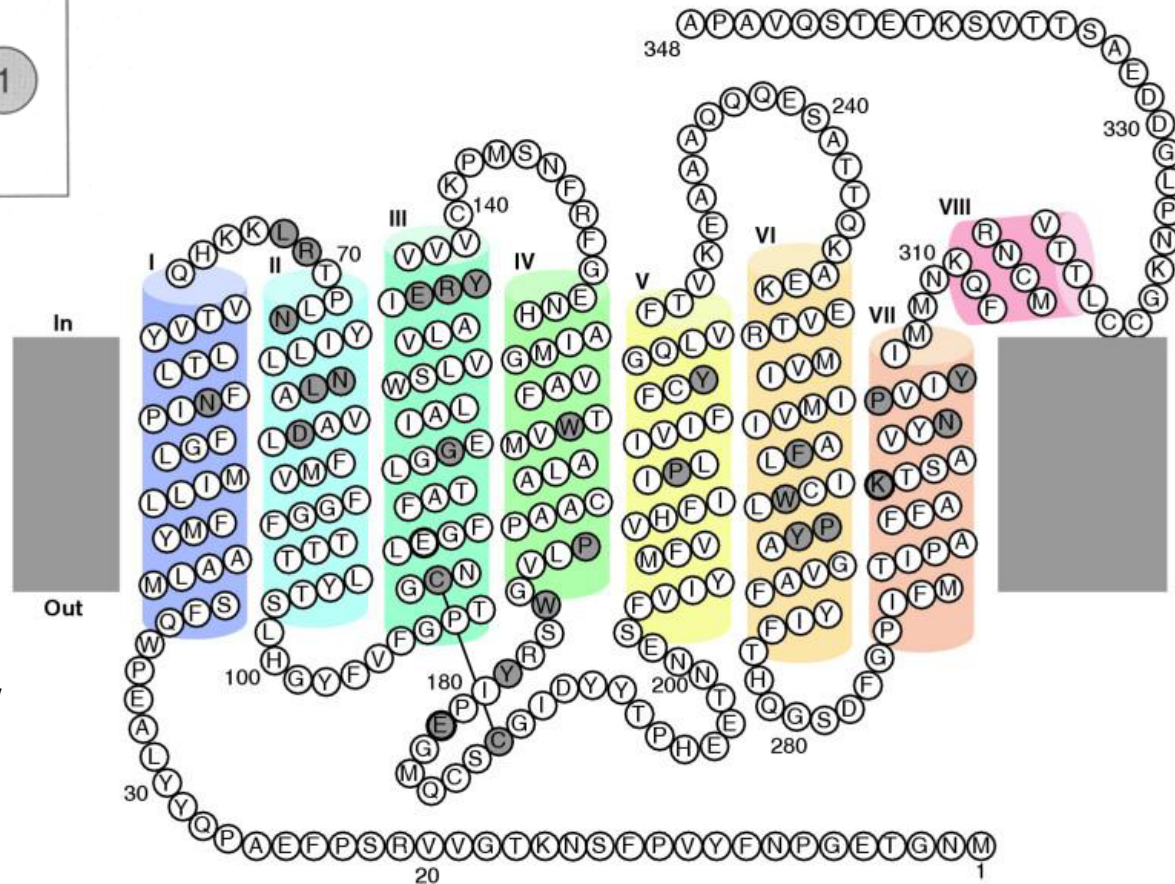


- **Visual pigment = opsin (protein) + chromophore (vitamin A)**
- **opsin = 350 amino acids**

Opsin is a protein that sits in the membrane



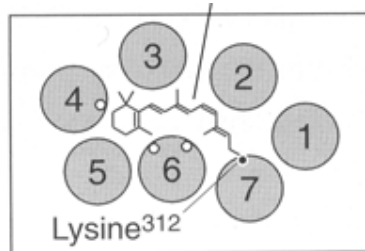
Top view



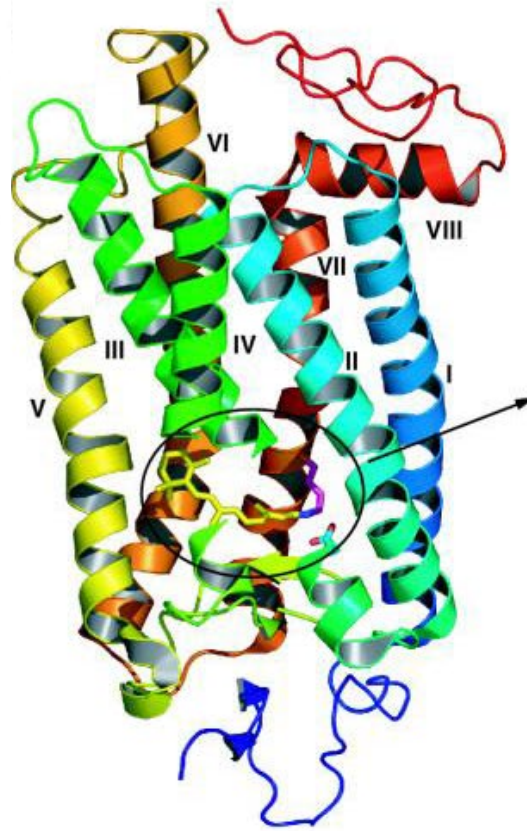
Side view

Opsin sits in the membrane

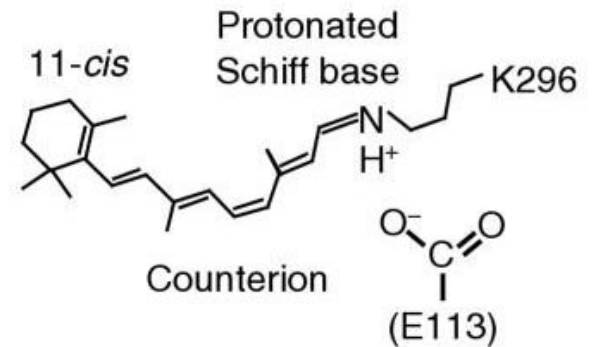
Opsin binds retinal



Top view

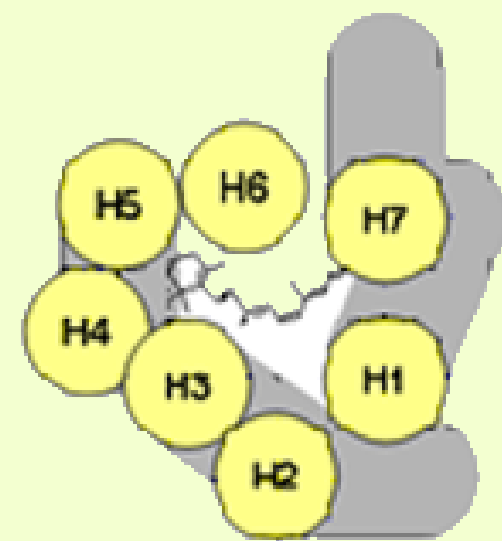
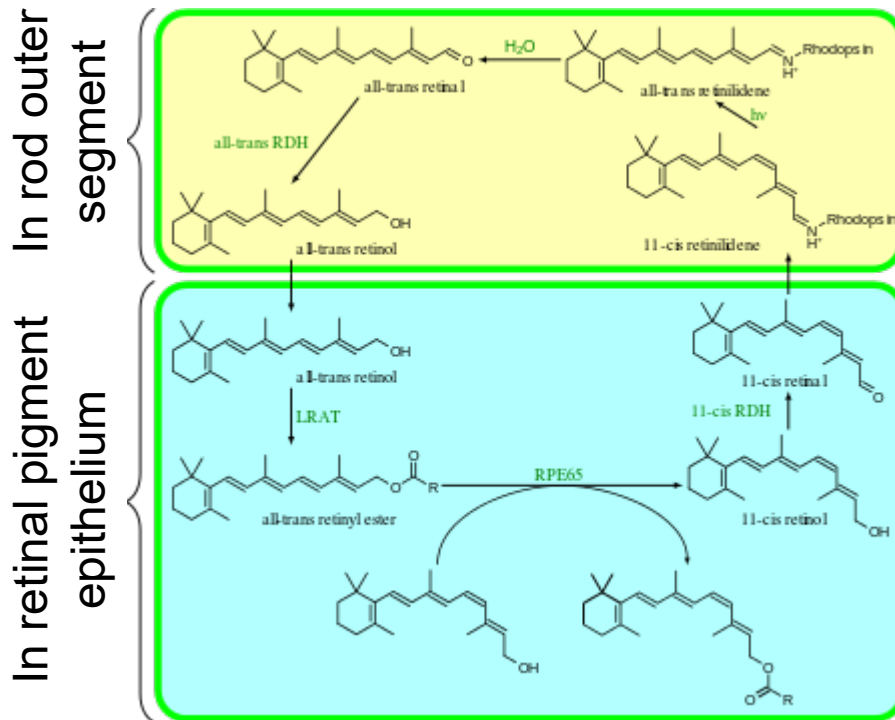


(d)



Retinal captures photons and changes shape

Opsin changes shape

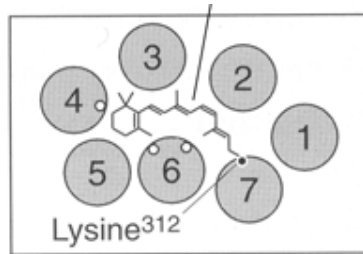


Visual Pigment

How does opsin differentiate between different wavelengths?

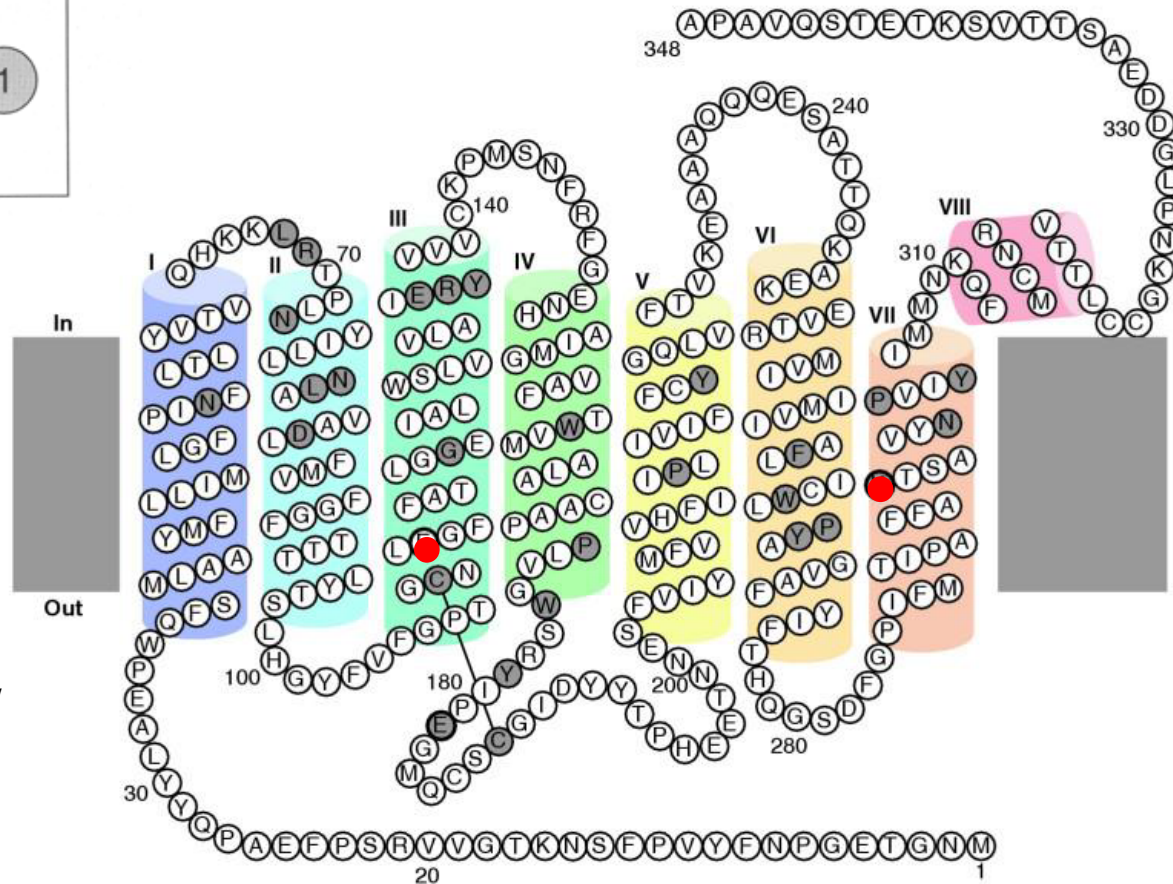


Opsin is a protein that sits in the membrane



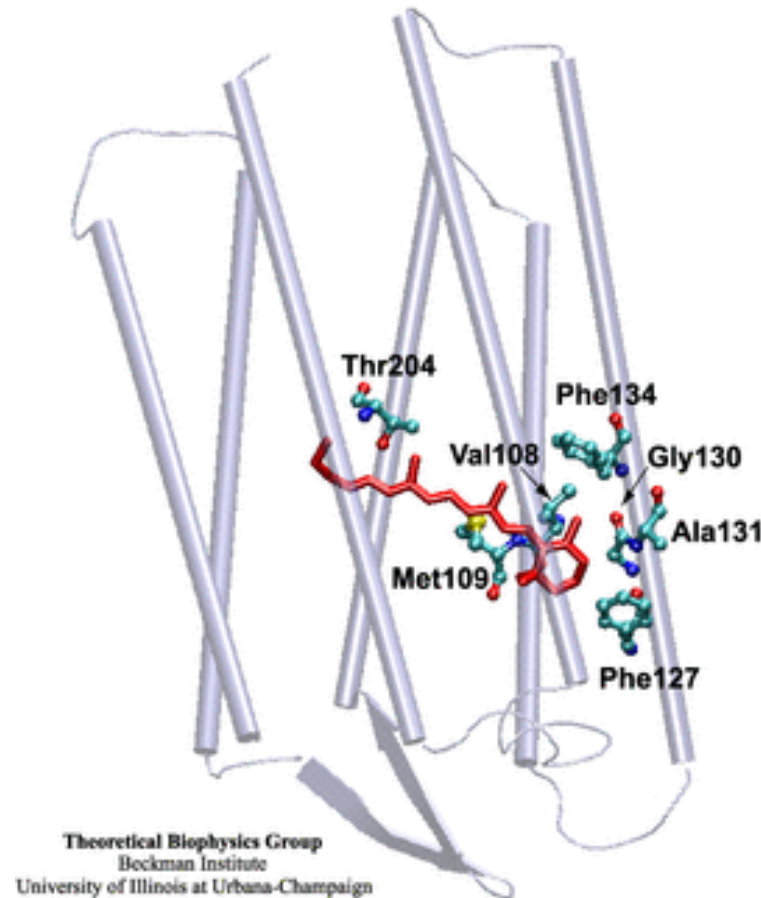
Top view

Side view



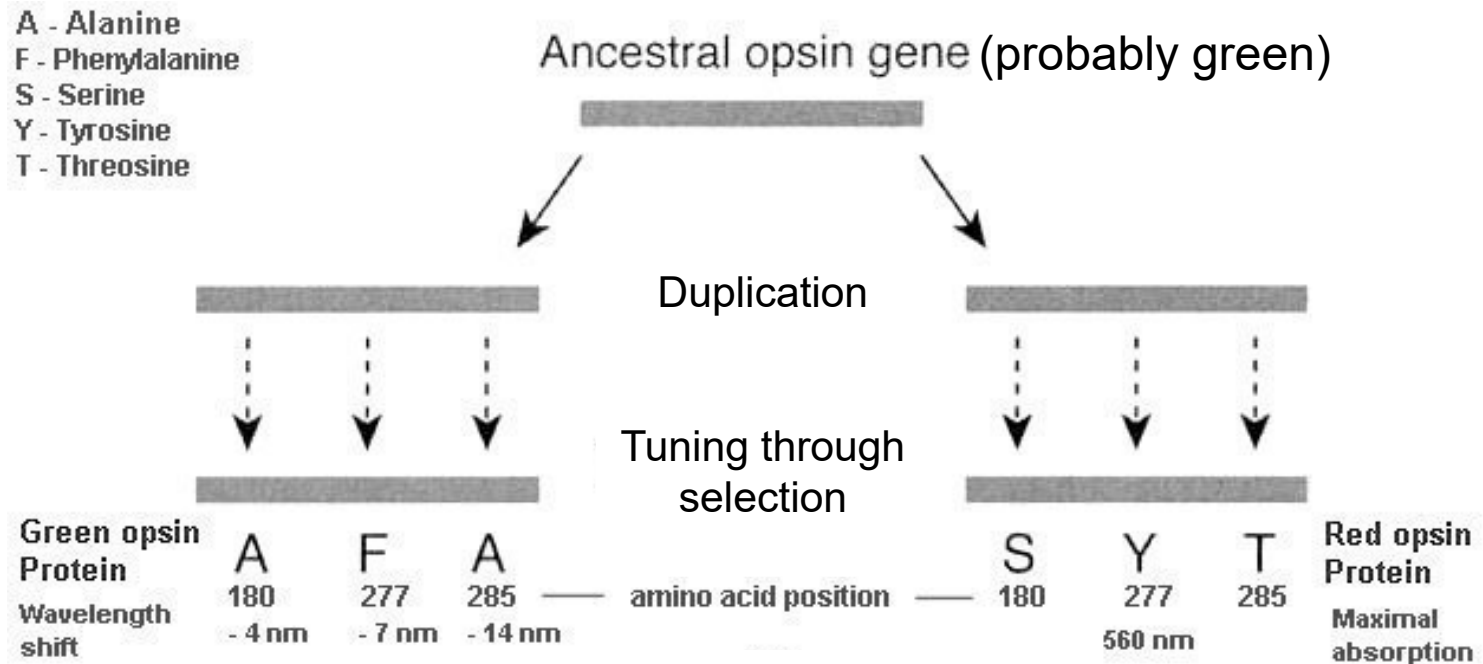
Opsin binds retinal using two amino acids:
Lysine (K) and glutamic acid (E)

Spectral tuning of the opsin protein



Key amino acid sites – interact with retinal

Changes in opsin DNA sequence underpin colour vision



Molecular evolution!

5 opsin classes based on amino acid compositions

- 🐭 4 cone opsin classes (1 cone = 1 opsin):



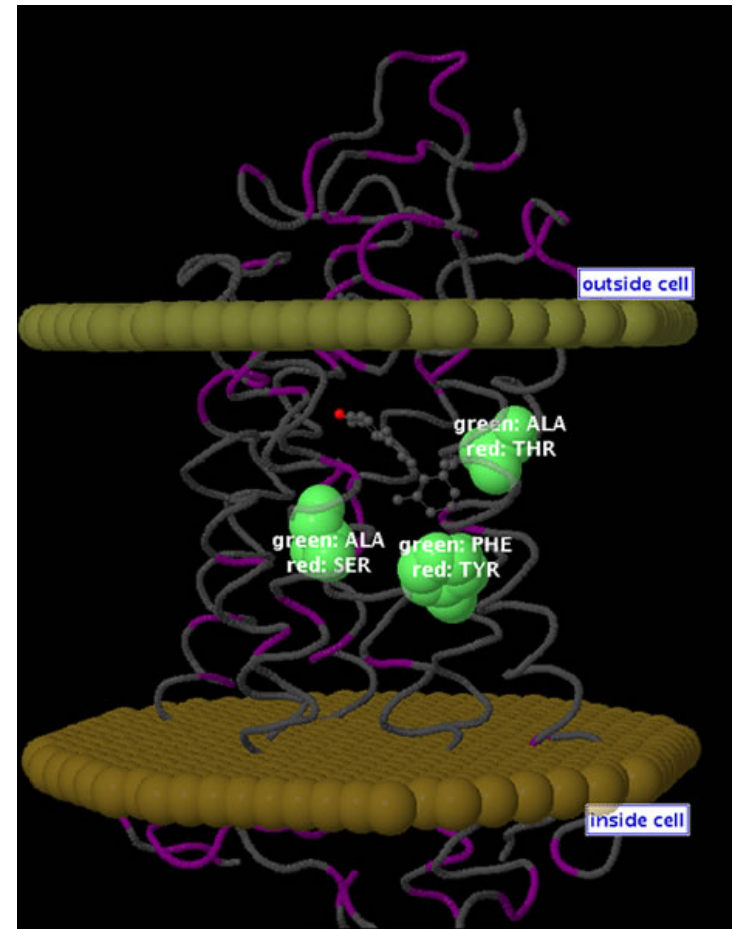
- 🐭 MWS = ancestral opsin
 - 🐭 not all opsins in all vertebrates
-

- 🐭 1 rod opsin class: rhodopsin (RH1)

Spectral tuning: Red vs. Green opsins

- ❖ Fifteen total mutations
- ❖ *Three* account for most of the spectral tuning

	@180	@ 277	@ 285
Red opsin	Ser	Tyr	Thr
Green opsin	Ala	Phe	Ala
<i>delta</i>	+ 3 nm	+ 7 nm	+ 14 nm



What should you know from this lecture?

Molecular basis of colour vision (how DNA sequence of opsins determines colour sensitivity)